us with those now received, since gradual changes in communities, as in individuals, are more patent to casual observers than to those who are always on the watch.

From some points of view the signs of the times are certainly not encouraging. It should not be forgotten that the manufacturing prosperity of this district depends to a great extent on the ample supply of a product which is brought to us at some cost from tropical and semi-tropical countries to be re-exported in the shape of manufactured goods. A political convulsion abroad, and this, unfortunately, is a casualty that may at any time be expected, or even the determination on the part of other nations to starve us out, however short-sighted such a determination might be, might cut off our supplies and disable us permanently as we were partially disabled twenty-five years ago. If to this be added the fact that foreign nations are becoming increasingly hostile and exclusive commercially, we cannot feel surprise at the dismal forebodings entertained and the confident predictions of decline uttered by some who claim to know all the facts. I ought to apologize for alluding to so gloomy a subject on the occasion of this to a great extent festive gathering, but then men of science like to look at a question not only from a hopeful but from every point of view. Fortunately on this question they are not called upon to pronounce any opinion one way or the other.

Should this be the last time that Manchester shall entertain the British Association in the day of its prosperity, I can only say with the German poet—

> "Schliesst den Kreis und leert die Flaschen!
> Diese Sommernächte feiernd,
> Schlimme Zeiten werden kommen,
> Die wir Auch sodann ertragen."

Whether in prosperity or adversity I feel sure that this city will always endeavour to entertain its visitors to the best of its ability. On the present occasion I may with confidence on the part of the chemical world of Manchester offer to the many friends from near and far who honour us with their presence at this meeting a most hearty welcome.

SECTION C.

GEOLOGY.

Opening Address by Henry Woodward, LL.D., F.R.S., V.P.G.S., President of the Section.

Since I received the friendly intimation from Prof. Bonney your distinguished and able President of last year, that the Council of this Association had done me the honour to select me to occupy the Presidential chair of this Section which he had vacated, I have been greatly exercised as to what subject to choose for the brief address with which it has now become customary to open the session. Not that there is any lack of materials ready to hand for the purpose—on the contrary, the subjects embraced by geology are now so varied and extensive that the effort to focus them in a single mind is ever becoming a more difficult task to accomplish, and demands the literary skill of a Lyell or a Geikie to marshal and arrange them from year to year in a manner suitable for presentation to you at our annual gathering.

Foremost in interest must necessarily be that which relates to our home affairs, and in this I have been most kindly favoured by Dr. A. Geikie, the Director-General of the Geological Survey of Great Britain, who sends me a brief notice of the progress of the Survey for 1886, taken partly from his Annual Report as Director-General and partly from information supplied by the office through the kindness of Mr. William Topley, our Recording Secretary. The following is the statement which I have received:—

The survey of the solid geology of England and Wales was completed at the end of 1883, and the field staff has since been occupied in surveying the drift deposits, making at the same time such revisions of the ordinary (solid) geology as may be necessary. In the north and east of England the drift and solid have been surveyed at the same time. The areas examined in the earlier days of the survey, in the south, centre, and west of England, and in Wales, were done for the solid rocks only.

In order to meet the great need for a general map of England and Wales on a moderate scale, one is being engraved by the Survey on the scale of 4 miles to 1 inch (1 : 253440), and will be issued in fifteen sheets.

A few of the survey memoirs relate to large areas, and give complete descriptions of the formations therein exposed, but most of the memoirs are explanations of special sheets of the map. A series of monographs is now in preparation giving full descriptions of special formations. Mr. Whitaker has charge of that on the Lower Tertiaries; Mr. H. B. Woodward and Mr. C. Fox-Strangways are preparing the Jurassic memoir, the former taking the rocks south of the Humber, and the latter those of Yorkshire; Mr. Jukes-Browne is writing the Cretaceous monograph; and Mr. Clement Reid that on the Pliocene beds.

In Scotland some advance has been made in mapping the important and complicated area of the north-west Highlands. The surveyors there were chiefly engaged between Loch Stack and Ullapool, subsequently completing the area about Durness and Eriboll. The other parts of Scotland now being surveyed are the north-eastern and western side of the Grampians, all south of the latter having been already completed.

Ireland is entirely surveyed with the exception of a small area in Donegal, which will probably be completed this year. This district is of interest from its resemblance to the north-west Highlands, and from the problems which it presents as to the origin of the crystalline schists. The recent discovery of organic remains amongst the Donegal schists adds additional interest to this inquiry.

The publications of the Survey during the past year are as follows: England and Wales, six sheets of the map, two sheets of horizontal sections, three of vertical sections, and six memoirs; Scotland, three maps and one memoir; Ireland, two maps and six memoirs.

The next matter which has arisen since our last meeting relates to our colonies, and comes to us in the shape of a message from the retiring President of the Association, Sir William Dawson, who has embodied his ideas in a letter to the President of the Royal Society (Prof. Stokes), copies of which have been sent also to all the learned Societies. To the former I am indebted for a copy accompanied by a favourable report thereon from the Royal Society of Canada.

As the object of this communication is one in which I am sure we, as Englishmen, must all feel a hearty sympathy, appealing as it does to our patriotism in its widest sense, as well as to our devotion for and interest in the science of geology, I feel I shall not need to apologize for introducing it to your notice here.

We are invited by it to enrol ourselves, as geologists, in a Federal Union, composed of all our brethren at home, in our colonies, and in all the dependencies of the British Crown. Nor are we to stop here, for when this has been satisfactorily accomplished it is suggested that we should invite our English-speaking cousins of the great United States, with whom we are already in such close alliance upon so many objects of common scientific interest, to join our Geological Confederation, and, having thus obtained an overwhelming majority, we are to proceed—without armies or vessels of war—to extend our peaceful conquest over every country on the habitable globe, urging and persuading those countries which have not established geological surveys to do so forthwith, and inviting those which have surveys of their own to join our British Association Geological Union. And when all has been accomplished in this direction our exertions as a confederacy may well be extended to secure the mapping of all those outlying regions of the earth's surface at present imperfectly known or still geologically unexplored.

Suggestions such as these could hardly come at a more fitting and appropriate moment, for are we not now on the eve of the completion of the geological surveys of the British Islands? if such a task can ever be said to be completed which has occupied the attentive study of so many able geologists during the last eighty years or more, and from the very nature of the case must always require additional research and revision.

India, Africa, and our colonies may all hope for future assistance from the many geological students now being trained in our schools and colleges, who may not be required in the near future for home surveys, and must needs go further afield to win their title of admission to the ancient and honourable order of "Knights of the Hammer."

This idea of scientific federation was referred to by Prof. Huxley in his Presidential Address to the Royal Society in 1885, and subsequently by the present President (Prof. G. G. Stokes) in November last.

If we would devise a scheme by which we might from time to time, recognize in a suitable manner—whether by corresponding membership, or honorary fellowship, or by medals and awards—as Prof. Huxley has suggested, the good scientific work being done by members of the many Societies in our distant colonies of Canada, South Africa, Australia, New Zealand, and elsewhere, that would indeed be a step in the right direction, and would doubtless prove most helpful and encouraging to all our fellow geologists abroad.

The Geological Society of London, no doubt, to some extent covers this ground; but it should be noticed that in the view of this Society, our colonies and other dependencies are not, and I think rightly, recognized as foreigners, that designation being employed for those who are not in any sense subjects of the Queen.

As a consequence, the geologists of our colonies are not looked upon as eligible for honorary connexion with the Geological Society, and though in the distribution of the medals and awards their work is no doubt noticed, yet that is now so important and extensive that it might be desirable to secure for it a more specific and extensive recognition than has hitherto perhaps been possible.

Might we not also through the home influence we could bring to bear by means of this great Section of the British Association succeed in inducing our practical colonial Governments to see the enormous commercial as well as scientific gain that must eventually accrue to themselves if they would, with wise liberality, continue to completion their much-needed geological surveys, instead of (as has too often happened) abandoning the work before its end has been attained, or making its maintenance from year to year contingent on the chance discovery of gold, or the successful boring for coal or water—results not always to be attained within twelve months by a geologist in a new country, however good he may be, unless he have a fairy godmother or a divining-rod at his command?

If by means of our confederation such useful and helpful works can be inaugurated, we shall have fulfilled an object well worthy the initiation of Sir William Dawson, and of all those whose names may be connected with so laudable an undertaking.

Nor need such a development of the work of this Section interfere in any way with the labours of the "International Geological Congress," which occupies a distinct field of its own; for whatever we might accomplish in carrying out the suggestions put forward by Sir William Dawson would really be in effect to second and support—not to hinder—the work of that most useful body of geologists.

Our next topic relates to foreign affairs.

The International Geological Congress, which met in Bologna in 1881, and in Berlin in 1885, will hold its next meeting in London in 1888. This year the Committee of the Congress on Geological Nomenclature will meet during the Association week at Manchester. Prof. Capellini, of Bologna, is the President of this Committee, and Prof. Dewalque, of Liége, is the Secretary. Its object is to discuss various questions respecting the classification and nomenclature of European rocks, and to report thereon to the Congress in London.

It is quite certain that a large number of Continental and American geologists will be present in London next year, and it rests with English geologists to determine whether the meeting shall be as successful as those which have preceded it. The Berlin Congress left the arrangement in the hands of a small Committee of English members (Messrs. Blanford, Geikie, Hughes, and Topley), and advantage will probably be taken of the presence of so many geologists in Manchester to further the organization of the English meeting.

The occasion of the Congress visiting London next year should also be a sufficient reason to enlist new members here, and it is to be hoped that a very cordial reception will be accorded to all those who come from abroad to attend the meeting. It ought to be a great success, and deserves our warmest sympathies and co-operation.

Geology seems, at present, to be passing through what may not inaptly be termed a transitional or metamorphic period in its history, when old-established ideas are rapidly melting away, and under fresh influences are crystallizing out into quite other forms.

"New lights for old" is the popular cry both in science and politics, and, like the Athenians, nothing delights us more than to hear tell of some new thing.

If the proposition lately made by Prof. Judd, the President of the Geological Society in London, in his recently delivered Anniversary Address, holds good, that mineralogy is the father of geology, it seems not improbable that, like Saturn's offspring, our science is in danger of being devoured by its reputed parent; for certainly mineralogy, in the form of petrology, has of late years most largely occupied the geological field, whilst palæontology, once the favourite child of geology, is in its turn threatened with imminent extinction, as a separate study, by biology, which, without any substantial gain, now replaces, *in name only*, the hitherto better known sciences of botany and zoology.

Indeed, could the views so eloquently put forward by Prof. Judd be maintained, mineralogy itself would have to be added to the list of sciences included under biology. But notwithstanding the well-known aphorism of Linnæus—

> "Lapides crescunt; Vegetabilia crescunt et vivunt;
> Animalia crescunt, vivunt, et sentiunt"—

the growth of the first is of a totally different nature from that which takes place in the last.

Minerals, or more properly crystals, increase or grow in size by additions to their *external surfaces* of molecules of matter identical with themselves. They are therefore as a rule homogeneous throughout, almost rigid, and remain under ordinary circumstances unchanged irrespective of time.

Plants and animals, on the contrary, increase by intussusception, or the taking of matter within their tissues. Their bodies are *not homogeneous*, and they exhibit all the various phenomena of growth and decay.

We stand, then, still like "watchers on the threshold," not yet admitted beyond the veil. We are not prepared to include minerals in the study of living beings, nor are we, I submit, any nearer the solution of the problem, What is life? whether we call it "*vitality*" or "*vital force*," nor can we produce it like "electricity" or "electrical force" by the aid of mechanics. That it has existed ever since our planet became habitable by living organisms is beyond doubt; and since life first dawned it seems equally certain that this "vital force" was never at any time extinguished, but, like the sacred flame of Iran, its light has always gladdened our earth with its presence.

I have already referred to the vastness and diversity of the domain which Geology claims as her own; indeed, we might, if so disposed, pursue our subject in its *cosmical aspect*, and, inviting the astronomer and the physicist to our aid, proceed to consider the evolution of our earth and its subsequent history as a part of the solar system.

Or, taking up *geognosy*, we might inquire into the materials of the earth's substance and the chief rocks and minerals of which its crust is built up.

Should *dynamics* charm us, then we may study the various agencies by which rocks have been formed and altered, and the frequent changes in relation to sea and land which the terrestrial surface has undergone in former times.

Does *rock-architecture* attract us? It is ours to inquire how the various materials of the earth came to be arranged as we find them—whether wrought by living agents, or ejected by volcanic forces, or laid down quietly by water.

Or is *chronology* the object of our study? Then our task will be to investigate the well-marked succession of the stratified rocks and the sequence of events which they record.

Again, we might prefer the *physiographical aspect of geology*, embracing the history of the features of the earth and the causes which have brought about its varied conditions of continent and ocean, of mountain and valley, hill and plain, making up that grand diversity of surface which constitutes its scenery.

Yet more, it is within our domain as geologists to investigate *the past life of the globe* through all its successive changes and to trace it from its earliest dawn in pre-Cambrian times down to its grand development at the present day.

One result of the very vastness of this kingdom is that there is a tendency amongst its subjects to form into separate constituencies, and these in an incredibly short time evolve languages of their own, so that, unless this fissiparity can be successfully arrested, we shall speedily repeat the story of "the confusion of tongues," and our geological tower, which once promised by our combined labours to reach grandly heavenwards, may soon cease from building altogether.

This incoherence in our body politic may, I think, be traced to that great development by the microscope in mineralogical geology and petrology, which has no doubt been necessitated by the investigation of those remote pre-Cambrian or Archæan rock-masses in the north-west Highlands, Shropshire, the Malverns, South Wales, Cornwall, and the west of Ireland, whose fossils, if they ever existed, have been entirely obliterated[1] by the changes which their matrix has undergone, and whose very stratification has been lost by metamorphic action. In such investigations some of our ablest geologists have now been for long occupied with the best possible results, and Bonney, Callaway, Cole, Davies, Geikie, Hicks, Hull, Judd, Lapworth, Peach, Sorby, Teall, and many others have been labouring most zealously on these most ancient sediments, barren though they be of life forms, and often destitute of bedding.

It is refreshing, however, to find Prof. Judd at times abandoning volcanoes, and turning his attention most successfully to lizard-hunting with Prof. Huxley in the Elgin sandstones, or studying the micro-organisms in the cores from the Richmond boring or the valley of the Nile; to see Dr. Hicks leaving his patron St. David far behind, and digging for bones in the pre-Glacial caves at St. Asaph. Prof. Lapworth, too, we see avoiding Cape Wrath, and discoursing on the beauties of Canadian Graptolites and the Cambrian rocks at Nuneaton.

Thus there is still a bond of union connecting stratigraphical geology and palæontology and a common ground of interest whereon all geologists may meet. It should then be our endeavour not to dissociate ourselves or our interest from any subject of geological inquiry, but to maintain the union between all branches of our science and with all workers in whatever field they may labour, adopting for our motto the ancient maxim, "*Vis unita fortior est.*"

Especially should we adhere to the study of palæontology, seeing that it is indissolubly connected with one of the earliest chapters in the history of our science. Indeed, through the evidence afforded by organic remains, William Smith (better known by the title given to him by Prof. Sedgwick, "the father of English geology") was led to those remarkable generalizations as to the identification of strata by means of their contained fossils, which have exercised so great an influence over our own science during the past ninety years, and is still the guiding principle on which our classification of the sedimentary rocks is based. What Wollaston has done for mineralogy and crystallography, William Smith initiated for stratigraphical geology; and we cannot overlook our obligation to Smith whilst we reverence the work of his distinguished contemporary, Wollaston.

Palæontology, or the study of ancient life forms, stands somewhat in relation to geology as the science of archæology does to history, or as zoology and botany to physical geography. But, whereas the investigator of recent living forms deals with entire organisms and can study both their morphological and their physiological history as well as their geographical range, the palæontologist has too often to deal with imperfect remains, many of which have no exact modern representative, and has, in consequence, to look for and seize upon minute characters for his guidance, which the worker on recent forms would probably neglect as too trivial for even specific diagnosis.

The palæontologist, if he would succeed, must in fact be a trained zoologist or botanist, as the case may be, and an accomplished geologist also; such combinations of qualities like those possessed by the earlier race of "naturalists" are less frequently to be met with at the present day. They represent amongst us the same class of men as the "general practitioner" does in medicine; they are the all-round good scientific men, but not "specialists."

Biology, or the study of living things, has now become so vast a field that everyone is compelled to take up some special subject, and in striving to master it he makes his reputation as an authority on this or that group of organisms.

There is much to be said in favour of such a method of working, but I hold that everyone who so elects to spend his life must first of all pass through a thorough grounding in general biology, and should on no account take up special work until he has mastered thoroughly the general principles of scientific classification and the various types of organized beings, otherwise he will be for ever viewing all Nature with distorted vision, seeing, in fact, "men as trees walking." If as a student he shall have been nurtured wholly on the anatomy of the *sole*, all objects will be viewed from the stand-point of that one-sided fish. If the cockroach has engrossed his youthful studies, all nature will swarm with *Periplaneta orientalis*.

We have to guard against the starting of *student-specialists*. They must begin by being "general practitioners" if they are ever to do any good in the world of science, and after serving their time in a museum or elsewhere, then by all means let each follow his own "bent" and devote himself to some particular group, as did Davidson to the *Brachiopoda*, to the exclusion of all else.

It is the absence of "all-roundness" which has retarded more than any other thing the constant interchange of ideas between zoologists, botanists, and palæontologists, without which science languishes. Biologists as a body do not care to look at or study fossils; they see neither form nor beauty in the petrified fragments of a plant or animal such as would induce them to study these more closely, and they turn to the exquisitely perfect specimens of recent objects in their cabinets with a sigh of relief. But *Nemesis* is at hand created by our modern system of extreme biological training. The student of to-day is averse to the systematic work of both zoology and palæontology in our museums, and, technically inclined, craves for nothing so much as to be allowed to embed some interesting embryo in paraffin and cut it into 10,000 slices.

As a consequence our museums will suffer unless we can revive amongst our students a taste for and a love of general natural history; such, we mean, as the *taste for Nature* which excited the enthusiasm of Charles Kingsley and stimulated the zeal of Charles Darwin. We cannot all sail round the world as did Banks and Solander, Darwin, Huxley, Hooker, Wyville Thomson, Moseley, and so many other naturalists, though the mere act of travelling has now become so ridiculously easy that our own Association awoke one morning in Montreal, and may, for aught we know, find itself some day in Sydney or Melbourne! But we can fully appreciate Nature in a dredging expedition or feel her influence on a moor or mountain, in a quarry or down a mine.

What we want for our students in these high-pressure days are less frequent attendance in the examination room and a more frequent examination of Nature in the field. Our professors must take their men more often afield, and show them how to collect specimens and familiarize them with the aspects of natural objects as seen *without microscopes*, and they will return to their studies with far better and keener eyesight after their own *macroscopic* vision has been enlarged by contact with Nature.

Whoever then takes up the study of fossils must also be well acquainted with the structure of living animals and plants; he may also be expected to go on adding to his store of biological knowledge—but as some division of labour is absolutely essential, the man who pursues palæontological research must be prepared to concentrate all his energies to the elucidation of these extinct organisms, studying, but not occupying himself in describing, recent forms.

In order, however, to work satisfactorily at any particular group of extinct organisms, his eyes and his understanding must go through a long and careful training before he will be able to interpret correctly the appearances presented by the specimen before him, and to avoid the fallacies by which he is liable to be misled, arising out of the necessarily imperfect materials and their different modes of preservation in the matrix.

He must learn to distinguish between a suture and a fracture, and to know when a specimen has been distorted by cleavage or other mechanical cause, or altered by mere difference of mineralization. Such deceptive appearances have too often led to the multiplication of species, and even the creation of spurious genera.

Thus occupied in the investigation of ancient life forms, he will in truth be only writing the first chapters on the botany or the zoology of the earth, and whilst his carefully obtained results are of the greatest importance to the speculations and conclusions of the geologist they are equally essential to and a part of biological science.

My friend Dr. Traquair has recently thus expressed, in relation to his own subject, what I have attempted to make more general:—"The man who satisfactorily investigates the structure or determines the systematic position of a fish or reptile *preserved in stone* is as much a zoologist as he who describes a similar creature *preserved in spirits*, though with this difference, that the former task is in some points rather the more difficult, seeing that we have *only the hard parts* to go upon, and these generally in a crushed, fragmentary, or scattered condition. And," he adds, "without a genuine interest in, as well as a thorough knowledge of, recent biology, no one can hope to produce work of any value in palæontology."

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[1] Traces of fossils are said to have been met with in Donegal, and I have just received evidence of Trilobites in the Upper Green Llanberis slates at Penrhyn, hitherto considered unfossiliferous!

Of course the value of all palæontological work, as of all zoological or botanical work, must depend entirely upon the care and exactness with which the work is performed.

Time, the great assessor of all human labours, will sit in judgment upon them and pronounce by their durability or instability the comparative value of each.

It appears to me that to the careful palæontological worker, as to the careful archæologist, the greatest merit is due if he succeed correctly in deciphering the too often fragmentary and blurred remains of a bygone age, and giving us in the present an accurate interpretation of a page from the life-history of the past.

Then, too, there is the geological aspect of palæontology. And here I may state that one of the charges made by a brother zoologist against us is "that we use fossils *merely* as counters by which to record the progress of geological time."

As well might exception be taken that the milestones along a turnpike road had been used by a traveller to calculate the length of his journey.

But omitting the word *merely* (for fossils have been made to give up many secrets to the investigator besides their age), I gladly accept the charge as conveying a great and important truth.

Do not the historian and the antiquary use the coins and medals dug from the ruins of the dead and long past dynasties of the world as sure guides in the chronology of the human period?

And may not the geologist also use "the medals of creation" as Dr. Mantell aptly called them—coined in no counterfeit mint, as the best and most trustworthy guides to enable him to establish the chronology of the stratified rocks of the earth?

Great then as is the benefit which zoology has derived from palæontology in enabling the zoologist to learn the earliest appearance in time of each group of organisms, and the modifications in structure, so far as we are enabled to ascertain them, which each may have undergone from the ancient to the modern period—it may be doubted whether even this valuable aid equals the service performed to stratigraphical geology by the careful study of organic remains—in enabling us to write the chronology of the rocks over so large a portion of the habitable globe.

Without fossils stratigraphical geology would be as unsatisfactory as it would certainly be uninteresting; with their aid it becomes, both in the field and in the cabinet, one of the most attractive and delightful of studies.

Owing to the very nature of sedimentary deposits, being of necessity either lacustrine, estuarine, or marine in origin, our knowledge of the ancient land surfaces of the globe is necessarily very limited, but we know much concerning its old marine areas. These are the more constant and widespread, and it is mainly upon these deposits, and not so much upon the more limited evidences of ancient land surfaces, that our chronology has been based.

Of the antiquity of cave-folk and their contemporary Mammalia we may expect to hear the very latest utterances from Prof. Boyd Dawkins and Dr. Hicks. The former is also to be congratulated upon his renewed work on the Mammalia in the Palæontographical Society's volume for 1886 (just issued). Prof. O. C. Marsh has added a further contribution to American palæontology in the shape of a memoir describing and figuring sixteen new species of Mesozoic mammals from the Upper Jurassic rocks in Wyoming, on the western slope of the Rocky Mountains. Mr. Lydekker has just completed Part V. of his most useful and much-needed Catalogue of the Fossil Mammalia in the British Museum, containing the Sirenia, Cetacea, Edentata, Marsupialia, and Monotremata.

The fossil birds remain to be catalogued. In the Reptilia it is refreshing to see Prof. Huxley once more taking up the pen and writing upon *Hyperodapedon* and *Rhynchosaurus* in his old vigorous and earnest style. We can only regret that his health precludes him from continuous labour, to the no small loss of science. Prof. Marsh shortly promises us his memoir on the Sauropoda, the plates of which are progressing rapidly to completion.

Our late veteran chief, Sir Richard Owen, although retired from active official duties, contributes a paper on *Galesaurus planiceps*, a Triassic saurian from South Africa, and a further memoir on *Meiolania* from Lord Howe Island.

Prof. Seeley and M. Louis Dollo are both occupied with Dinosauria, the former from the Cape (whence he has also detected part of a mammalian skeleton in the Triassic rocks), and the latter is adding to our knowledge of Iguanodon and other forms from the Wealden of Bernissart.

In the Amphibia, Prof. Dr. Herman Credner has added a most valuable paper on the development of *Branchiosaurus*, a small Labyrinthodont from the Keuper of Saxony, in which he has been able successfully to trace the development through a long series of individuals of a water-breathing naked larva of the Palæozoic epoch into an air-breathing adult form, clad in a strong coat of mail.

In fossil ichthyology, A. Wettstein has been occupied in the study of the Eocene fishes of the Glarus slates, and in his recent memoir he shows that out of one fish (*Anenchelum*), so constantly distorted by slaty cleavage, Agassiz had made no fewer than six species. The fish is now found to be identical with the living "scabbard-fish," *Lepidopus;* and the author reduces the forty-four species of Glarus fishes to twenty-three, and adds four new ones. Among the latter is the first fossil *Remora* yet met with, named *Echeneis glaronensis.* Its first dorsal is modified as a sucker, exactly as in the living *Remora.*

Baron Zigno, of Padua, has figured and described the first entire *Myliobatis* hitherto discovered in the Eocene of Monte Bolca.

M. Louis Dollo records the occurrence of two skeletons of *Carcharodon heterodon* in the Eocene of Boom, Antwerp, one measuring 7 metres, and the other nearly 9 metres in length. They are now mounted and exhibited in the Brussels Museum.

Mr. J. F. Whiteaves is commencing to publish the detailed descriptions of the Devonian fishes from Scaumenac Bay, Quebec.

Mr. James Wm. Davis, of Halifax, has produced a second monograph for the Royal Dublin Society. The first, which appeared in 1883, was devoted to the teeth and spines of Elasmobranch fishes from the Carboniferous limestone of Great Britain; the present monograph, illustrated by twenty-four plates, is devoted to the description of the fishes of the Cretaceous rocks of the Lebanon, and makes us acquainted with a wonderful series of Selachian fishes, representing nine genera and sixteen species, of which two genera and twelve species are new to science. The Ganoids comprise two species of Pycnodonts and two forms related to Amia; there are also a number of Teleostean fishes, amongst which are *Pagellus*, *Beryx*, *Homonotus*, *Platax*, and many other genera. Two species of eel, *Anguilla*, are the first Mesozoic examples recorded. Altogether we have ten genera and sixty-three species of fish recorded as new. The author is to be congratulated upon having contributed to fossil ichthyology one of the most extensive works published in recent years.

Mr. Arthur Smith Woodward (a former student of Owens College, Manchester) has this year also contributed numerous papers on fossil fishes: on *Ptychodus* from the Chalk; *Squaloraja* from the Lias; on the Brazilian genus *Rhacolepis;* on a Maltese *Holocentrum;* "On some Eocene Siluroid Fishes from Bracklesham"; and "On the Canal-System in the Shields of Pteraspidean Fishes."

Mr. E. T. Newton describes a *Semionotus* from the Trias of Warwickshire.

Both Mr. James W. Davis and Dr. R. H. Traquair have given us descriptions of the anatomy of *Chondrosteus acipenseroides* from the Lias of Lyme Regis.

Mr. William Davies describes two species of *Pholidophorus* from the Purbeck beds of Swanage, Dorset.

But the groups which have proved of the greatest service in the chronology of the sedimentary rocks have been the Mollusca, the Brachiopoda, and Crustacea (especially the Trilobita, Phyllopoda, and Ostracoda), the Echinodermata, Corals, Graptolites, Sponges, and Foraminifera.

It would be an interminable task merely to record the workers in the various sections of palæontology, but in glancing at these one cannot prevent many illustrious names arising in one's mind—many who have finished their work, and are reckoned among the fathers of the science, but many also who are still our companions, and from whom we may expect further important help before they lay down their hammer, their lens, and their pen.

In the Cephalopoda the task so lately left by our countryman Dr. Wright, after a long life devoted to palæontological science, has been taken up by Mr. S. S. Buckman, who has already presented one fasciculus of a monograph on the Ammonitidæ of the Inferior Oolite.

The Gasteropoda of the Oolites have an able historian in Mr. W. H. Hudleston, whose contributions on this subject enrich the pages and plates of the *Geological Magazine* and the Proceedings of the Geologists' Association; the Palæozoic forms are in the hands of Dr. Lindström.

The Lamellibranchiata cry for help at present in vain, and we regret more than ever the loss of Stoliczska, who promised such good work had his life been spared.

The Brachiopoda, so long and so well cared for by Dr. Davidson, now also demand a successor to that illustrious name.

The Polyzoa, which suffered so severe a loss in the death of Mr. Busk, have since been well cared for by Mr. Arthur W. Waters and Mr. Vine.

Until quite lately, the oldest fossil insects known were the six fragments of wings of Neuroptera, from the Devonian of New Brunswick, obtained by Mr. C. F. Hartt and described by Mr. S. H. Scudder. More lately the wing of a cockroach has been obtained from rocks of Silurian age in Calvados, France; whilst almost simultaneously fossil scorpions have been met with by Dr. Hunter, of Carluke, in the Upper Silurian of Lanark, and determined by Mr. B. N. Peach, and from the Upper Silurian of Gotland, described by Dr. Lindström.

These discoveries carry back our records of old land surfaces to a far more remote period than that of the Coal-measures, vast as its distance is removed from recent times.

Mr. B. N. Peach is the discover of several scorpions, and I have also recently figured and described three new forms of cockroach and several spined myriapods from the Coal-measures. Another cockroach, also new, which has been kindly sent me for study by Mr. Peach, brings to our knowledge a larval stage of *Blatta* from the Scottish Carboniferous.

Dr. McCook has just added a genus of spiders, *Atypus*, to our Eocene beds from the Isle of Wight.

The Crustacea have found in Mr. B. N. Peach and in Prof. Rupert Jones able and willing historians. Mr. Peach has taken up the Carboniferous Macrouran Decapods, and Prof. Rupert Jones the Palæozoic Phyllopoda, aided by myself; Prof. Jones is attacking the Tertiary and Cretaceous as well as the Palæozoic Ostracoda, so that his hands will be full for many years to come.

The Echinodermata have lost Dr. T. Wright, who for years acted as their monographer in the Palæontographical Society's volumes, but they have secured the services of other accomplished naturalists. Mr. Robert Etheridge, Jun., and Dr. P. Herbert Carpenter have produced a grand monograph on the Blastoidea in the British Museum; and no doubt this is but the beginning of good things to come, for although Mr. Etheridge has entered upon a new sphere of work in the Australian Museum, Sydney, Dr. P. Herbert Carpenter hopes to take up the stalked Crinoids before long, and Mr. Percy Sladen, who, with Prof. P. Martin Duncan, has already done so much good work amongst the Indian Echinoderms and elsewhere, promises to take the star-fishes in hand for us later on.

The Corals have many friends, chief amongst whom is Prof. P. Martin Duncan, and Prof. H. A. Nicholson, and various other excellent workers, but they are even a more difficult and a less attractive group than the Echinodermata, and their determination is not so satisfactory owing to their irregular and heteromorphic growth.

The Stromatoporoids have lost an investigator in the field in Arthur Champernowne, whose unexpected and early loss we all deplore. But in Prof. Nicholson they will find a most careful and painstaking monographer, who has already given us one fine instalment of his work in the Palæontographical volume.

In Prof. C. Lapworth we have an exponent of the structures and affinities of the Graptolites as a class and of their stratigraphical position in the rocks unsurpassed by any other worker. With him must be associated the names of Barrande, Carruthers, Hopkinson, Nicholson, and a long list of foreign workers, all of whom, however, look upon Lapworth as the highest authority in this group.

In the Spongida we are especially indebted to Dr. G. J. Hinde, first for an excellent well illustrated quarto catalogue of these organisms in the geological collection of the British Museum, and secondly for the Palæozoic part of a fine monograph of these for the Palæontographical volume just issued.

Nor must we omit to recall the names of Prof. Zittel, of Dr. Carter, of Prof. Sollas, and many other able workers in the fossil sponges.

In the Foraminifera we naturally recall the names of D'Orbigny, D'Archiac, Carpenter, Parker, Brady and Jones, and Sir William Dawson, our illustrious ex-President. Prof. Rupert Jones is still at work on this group, and has recently published a paper on *Nummulites elegans* from the Eocene beds of Hampshire and the Isle of Wight.

Of late years fossil botany, too long neglected, has taken a place of note in all those inquiries concerning the origin of floras, the age of the stratified rocks, the former distribution of land surfaces, and especially in all questions relative to the climate of the globe in past times.

Passing over the earlier period of the present century, when fossil botany was known only by the works of Artis, Witham, Schlotheim, Sternberg, Goeppert, Cotta, Lindley and Hutton, Steinhauer and Adolphe Brongniart, we have to recall the names of other workers who have only passed away in our own time, such as Binney, Bunbury, Corda, Bowerbank, Heer, Unger, Schimper, and Massalongo.

In the period of fifty years, whose completion we have just celebrated, the names of our countrymen Binney, Bowerbank, Williamson, and Hooker, stand prominently forward contemporarily with those of Geinitz, Unger, Rossmasler, and Schimper, in Germany. In 1845 Dawson and Lesquereux entered the field in America, Hooker in England, and one of the ablest writers on fossil plants, Oswald Heer, entered upon his great work in Switzerland. In 1850 Massalongo in Italy, and von Ettingshausen in Austria, were added to the roll of famous palæobotanists, and in 1853 Newberry joined the American field of research. In 1860 the work so long abandoned by Brongniart, in France, was taken up by de Saporta, and it is no small gratification to have him with us here to-day, and to welcome him amongst our distinguished foreign guests.

About the same time my friend and colleague William Carruthers commenced to write on fossil botany, and brought to bear upon the subject that accurate and careful knowledge of living forms without which such investigations must always prove but futile.

It is extremely difficult to estimate the number of species of fossil plants that had been described up to the year 1837, but it probably fell far short of a thousand. In 1828 less than 500 species were known to Brongniart.

In the first edition of "Morris's Catalogue," published in 1843, the number of British fossil plants recorded is 628.

Careful lists were published by Goeppert and by Unger in 1844 and 1845, giving a total of known species from 1600 to 1800.

In 1849 the number had increased, according to Bronn's "Index Palæontologicus" to over 2000, and the following year Unger enumerated 2421 in his "Genera et Species Plantarum," rather more than 500 of which may have been British. In 1852 Morris (2nd edition) gives the number of species as 750. Since then, chiefly through the labours of Heer, Ettingshausen, Lesquereux, Massalongo, Unger, and de Saporta, this number has been more than quadrupled. Mr. Gardner estimates that at least nine thousand species must have been described. This great increase is chiefly due to the more careful exploration of the Tertiary strata, in which the more highly organized and consequently more differentiated plant forms occur.

The number of plant remains described in Great Britain during the whole fifty years has been extremely small, but much has been accomplished in the study of fossil plants generally, and in this task no one has been more earnest than Prof. Williamson, of Owens College, Manchester.

His investigations of the plants of the Coal period have been of the most exhaustive nature, and from his researches into their microscopic structures we are almost as well acquainted with the minute tissues of these ancient denizens of the forests of the Carboniferous epoch as we are with those in the parks around Manchester to-day.

Mr. Carruthers's "Memoirs on the Coniferæ and Cycadeæ, and on the Fruiting Organs of the Lycopodiaceæ" have greatly advanced our knowledge of these interesting types, heretofore but imperfectly known from their fossil remains.

Mr. R. Kidston has devoted himself most earnestly to the investigation of the fossil plants of our British coal-fields, and he has determined not to rest satisfied merely to work out the plants obtained by others in our museums, but he has visited all our coal-fields and searched the shales on the spot for himself. The results of his collectings may now be seen in the valuable additions made to the Coal-measure series of plants in the British Museum (Natural History).

But it is more especially in reference to the Tertiary flora of Britain that progress has been made of late years.

Thanks to the labours of Mr. Starkie Gardner, who has not only obtained abundant materials for an exhaustive monograph with his own hands from Sheppey, Alum Bay, Bournemouth, Reading, Mull, Antrim, and many other localities, but has already favoured us with several memoirs in the Palæontographical Society's annual volumes and elsewhere on the British Eocene flora, we may hope before long to have a more complete history at this period of our islands than we already possess of the flora of the Carboniferous age.

Nor has any research, favoured by the aid of this Association, brought so large a return in beautiful and instructive specimens to our National Museum of Natural History as have the investigations carried out by Mr. J. S. Gardner.

We must not omit to mention Mr. Clement Reid, who has so diligently traced many of the specimens of our existing flora in the Pleistocene strata of the eastern counties.

"Large numbers of ferns and gymnosperms," says Mr. Gardner, "have been discovered in Mesozoic rocks, but remains of the interesting monocotyledons which must have accompanied them are provokingly scarce. We know that palms, grasses, &c., appear at certain definite horizons, but we are ignorant regarding their ancestry. We know that temperate floras, largely composed of dicotyledons, flourished as far north as man has been able to penetrate, in the Cretaceous and Tertiary periods, but nothing in the least suggesting a transitional form has been found amongst them. Lastly, we have learnt that floras now indigenous to Japan and the Himalayas, to Australia and South America, once inhabited Europe, groups of wholly different plants succeeding and displacing each other in such rapid succession on the same spot as to suggest that the normal condition of floras is one of slow but perpetual migration, and that the term 'indigenous' has no geological significance."

In reference to the question of geographical distribution of organized beings in geological time, the conclusion is strongly forced upon us, from a study of fossil remains, that the great zoological provinces into which the earth's surface and the seas of the globe are now subdivided have been brought about by the limitation of species at no more distant date than the Secondary period, and probably even later than this.

That in Palæozoic times there must have been a great uniformity of marine conditions, and the fauna of each of the primary formations was consequently not only of vast duration but of world-wide extent, is evident.

When, as in Carboniferous times, we are enabled to study the contemporary land conditions of the globe, we find they must also have been very uniform, at least so far as the explored parts of this hemisphere are known, both the fauna and the flora at this epoch being co-extensive with the northern hemisphere, indeed, in all probability far wider, seeing that identical species occur in the Carboniferous series of Australia and North America. Even those well-marked lines which at present follow more or less closely the isotherms of our hemisphere seem not to have exercised the same influence on the fauna and flora as they do at present. Thus in high northern latitudes and within the Arctic Circle we find abundant evidence of life in Palæozoic, Mesozoic, and even down to Tertiary times, unaffected by latitude; so that we are justified in assuming that a far milder temperature extended to much higher northern regions than that which at present exists on the globe, and consequently that a larger portion of the earth's surface (as well as its seas) was then habitable.

How great, then, is the field of research still open to our investigation, and how far distant must that day be ere the last problem shall have been solved, and the last chapter written, in the ancient life-history of our earth!

> "We write in sand, our labour grows,
> And with the tide the work o'erflows."

With unskilled hand I have struck here and there only a few chords on the many-toned harmonicon of geology. I fear they may not all have vibrated quite in unison as a perfect composition would; but, however crude the performance has been, I trust that it will not be provocative of discord. If some few ideas suggest themselves as worthy of your acceptance, I shall not have spoken altogether idly, nor you have listened so long and so patiently entirely in vain.

NOTES.

DR. EMIL HOLUB has arrived in Europe, after three years of adventurous exploration in Africa, and although he brings with him only a part of his scientific collections—the rest having been plundered by the Mashukulumbe, a tribe to the north of the Zambesi—yet this fragment is certain to prove of great scientific value. It includes over 2000 specimens of birds, 27,000 of insects, and 6500 of plants. Dr. Holub brings with him also many hundred observations in meteorology and measurements of all nations. The collection will be exhibited in Europe; and it is stated that, if circumstances enable them to do so, Dr. and Mrs. Holub will resume their African explorations. They are expected to arrive in Vienna on the 15th or 16th inst., and will be officially received by the Austro-Hungarian Exploration Society.

A SLIGHT shock of earthquake was felt at Bonn and in its vicinity at fifty-two minutes past four on Monday afternoon, accompanied by a dull subterranean rumbling.

THE Government of India has sanctioned the purchase for the Lahore Museum of a zoological collection illustrative of Indian silk culture.

M. PAVIE, who undertook an adventurous journey from Siam into Tonquin, starting from Luang Prabang, has been compelled to return to Siam, having been driven back by bands of Chinese, who are described as ravaging the country.

MR. J. B. LILLIE MACKAY, of the Royal School of Mines, and at present Lecturer in Chemistry at Trinity College, Melbourne University, has been appointed Director of the School of Mines, Sandhurst, Victoria.

MR. OMOND, the Superintendent of the Ben Nevis Observatory, replying in the *Times* to criticisms in Parliament of the work of the Observatory, to which we referred in a note last week points out that the report of the Meteorological Office, on which these criticisms were based, merely states that Mr. Omond's telegrams were useless for a particular purpose, viz. forecasting storms. He then proceeds to state the position of the Observatory in the matter as follows:—"When the Ben Nevis Observatory was opened at the close of 1883, the directors offered to send the Meteorological Office daily weather telegrams—the only satisfactory way in which observations can be used for forecasting. The Office declined this offer, mainly on the ground of expense, but asked that occasional messages might be sent when any unusual or interesting events occurred, adding that these messages might be sent more frequently at first. I had some difficulty in understanding why the Office wished a record of sudden changes to be sent by wire instead of waiting till they got them in the ordinary way by post, but considered that the best way was to follow their instructions literally and send telegrams recording sudden changes or unusual occurrences, with a due regard to economy and with gradually diminishing frequency. A reiterated request for economy at the time of the introduction of sixpenny messages led to the entries sent being usually restricted to two hours' reading of the various instruments —one before the change in question had set in and one after it was fairly established. Though most sudden changes are connected with storms, yet a few of the messages recorded changes from bad to good weather, especially when the occasional great dryness characteristic of high-level stations began suddenly or in any unusual manner. How a Committee, 'composed of men of the very highest scientific standing,' had come to regard these messages, and especially this last sort, as 'storm-warnings' passes my comprehension. The question of the value to meteorological science of the Ben Nevis observations I may safely leave to abler hands—it needs no vindication of mine; but I must protest against the unfairness to me and the other members of the Ben Nevis Observatory staff of first asking for records of changes which have occurred, and then declaring them useless because they are not also forecasts of what is to be. It should be noted, however, that in two cases the record from Ben Nevis arrived at the